to interest the student of precious stones and of mind.

OLIVER C. FARRINGTON

The Anarchist Ideal and Other Essays. By R. M. WENLEY.

This contribution of Professor Wenley's must be accepted as it is offered, as a record of varied interests. The topics considered, which in part appeal to the man of science, are various. The essay which gives the name to the volume is entirely retrospective in its view and supplies a parallel in Greek life for the independence of thought and the revolt from established conventions, of which theoretical position the anarchist is a practical and an extreme expression; it is a study of the intellectual sources of the anarchist position. Its value consists in broadening the historical aspect of movements which in their modern setting are overshadowed by local situations. Similarly retrospective is the essay upon "Plutarch and His Age." The central position in the volume is given to a review of the early movement towards physiological psychology. This is an able presentation of the philosophical positions which preceded and guided the formation of psychology as a scientific pursuit. The complex origins are traceable primarily to German philosophers as well as to such men as Weber, Fechner, Lotze, Helmholtz and Wundt, whose philosophical interest was joined to their more rigidly scientific investigations. It is Professor Wenley's purpose to supply not a narrative of the contributions of these men, but rather an interpretation of the intellectual movement which guided them towards the consummation to which they severally but differently contributed. On the whole the two educational essays, the one on "Heredity and Education" and the other on the "University in the United States," give ampler opportunity for Professor Wenley's individuality of thought and for the display of the temper of his opinions. By long residence a member of the professorial guild in this country, yet by training and tradition equally at home in the intellectual perspective of English and Scottish universities, he is in a peculiarly favorable position to perform the functions of comparative criticism which he judiciously exercises. Considerate alike of the inevitable shortcomings of educational provisions in the pioneering stage and of the success which has attended them, he retains the fundamental critical attitude in view of old-world standards; he retains also the rare gift of seeing things as they are, despite the enveloping fog which optimism so commonly breeds. The chief note of his complaint is the neglect of individuality and the lack of professional opportunity within academic life for the man of parts, whose development does not conform to the conventional channels of preferment. In a like sympathetic spirit he attempts to portray for English readers some of the peculiar problems which beset American universities, and does so with remarkable success. From beginning to end the volume is characterized by a directness of statement and an insight into relations which gives the whole a higher value than the seemingly casual treatment suggests.

JOSEPH JASTROW

THE PHYLOGENETIC RELATIONSHIPS OF THE OYSTERS

DR. JAWORSKI, of Bonn, has given in the "Zeitschrift für Induktive Abstammungs- und Vererbungslehre" an interesting discussion of the phylogenetic relationships of the oysters. The material upon which he bases his new *Ostrea* genealogy was collected in the middle Jurassic (Dogger) of northern Peru.

Jaworski's theory is based on the discovery of a new ostreid in the Peruvian Jurassic of considerable dimensions—approximately those of a large *Ostrea virginica,* though much more massive—characterized by (1) incurved and strongly gyrate umbones (those of *Ostrea sensu stricto* are approximately straight); (2) by a broad and greatly elevated hinge area (that of *Ostrea* is moderately low, and either broad or narrow); (3) by a ligament partly internal and partly external, located in large measure behind the beaks and produced beyond the hinge area proper (that of *Ostrea* is wholly

internal, medial in position, and confined strictly within the hinge area); (4) by the presence of an anterior adductor muscle impression indicating the persistence of the anterior adductor in the adult stage (in *Ostrea,* the anterior muscle has been observed by a number of embryologists in larval forms though never in stages later than the nepionic); (5) by the presence of pedal impressions indicating a well-defined, though probably reduced foot (in *Ostrea,* the locomotor organ is the velum which persists throughout the free swimming stage, and the presence of a well-defined foot and byssus have never been established even in the embryo).

These observations have led Jaworski to the theory that the new form, the *Heterostrea steinmanni* Jaworski, represents the mid-Jurassic ancestral type from which the true oysters of the Cretaceous, Tertiary, and Recent were directly derived. In order to establish this new hypothesis, it is necessary to first overthrow some of the critical work that has already been done along this line and from which quite different conclusions have been drawn. The three most notable researches are those made by Jackson, of Harvard, Douvillé, of the French Geological Survey, and Steinmann, of Bonn. Jackson's work was done at the Museum of Comparative Zoology, and his approach to the problem was by way of the embryology of the oyster and a number of closely related mono- and heteromyarian groups. The oysters were watched through all stages of development of the egg, the spat encouraged to attach themselves to transparent media and the growth phenomena studied under magnification. He was thus able to confirm and elaborate many of the observations of Huxley, Horst and Brooks, notably those on the number and position of the adductor muscles during the earlier development of the form.

Ostrea, like all other pelecypods in which the embryonic development has been carefully worked out, passes through a monomyarian stage in which, curiously enough, the single adductor muscle is anterior in position, although it is not the antecedent of the anterior adductor of the adult. Then there is a short period at the end of the prodissoconch and the beginning of the dissoconch stages in which both the anterior and posterior adductors are present and typically dimyarian in position. About the third day after the animal has become attached, the anterior adductor evanesces, and only the posterior remains. The atrophy of the anterior adductor has been explained by purely mechanical action: in the dimyarian stage, the orientation of the soft parts is similar to that of the typical pelecypod; the mouth is approximately midway between the hinge line and the ventral margin and the antero-posterior axis is approximately parallel to the hinge; as soon as the spat become fixed, there is a shifting of this axis through almost 45 degrees so that the mouth lies close up under the hinge. This change in position brings the anterior adductor so near the hinge that it loses most of its efficiency; there is, therefore, a compensating increase in the size and effectiveness of the posterior adductor which is gradually shifted to a point of vantage near the central portion of the valves.

The character and mode of development of the soft parts, as a whole, have led Jackson to the belief that *Ostrea* is the sessile analogue and the direct descendant of the free swimming *Perna.* The difference in habit would readily explain the unequal valves and the absence of the foot in the one form and the equal valves and well-developed foot in the other. *Perna* is characterized, however, by a series of vertical cartilage grooves while in typical *Ostrea* there is a single trigonal sub-umbonal pit. Jaworski's criticism of Dr. Jackson's theory of the relationships seems pertinent: the very fact that the young of *Perna* possess a single sub-umbonal pit similar to that of *Ostrea* and the adults a series of pits implies a highly specialized type. The similarity of the young of *Ostrea* and *Perna* may very properly be due to descendence along collateral lines from a common aviculoid ancestor, but there is small evidence of any more direct relationship. Jackson considers *Exogyra* and *Gryphæa* derivative forms of *Ostrea* which have become highly modified.

Douvillé, like Jackson, considers the oysters as direct descendants of true aviculoids not from *Perna,* however, but from *Lima.* The sessile aviculoids are cemented, as a rule, by the right valve, while in the oysters it is the left valve that is attached. However, it is probable that Douvillé overvalues the systematic importance of this character, for in the inequivalved Pectens it is sometimes the right valve and sometimes the left which is the more convex. *Lima,* a significant fact to Douvillé, assumes an almost vertical position as indicated by the approximately equal valves and the presence in both of a byssal opening. Furthermore, the characters of the ligament are similar in the Ostreas and the Limas. The *Ostrea,* however, does not apparently attach itself by a byssus at any stage in its development. Jackson watched very carefully for such a phenomenon, but was unable to find any trace of it. On the contrary, the spat appear to attach themselves at the very beginning of cementation by the margin of the reflected mantle. If the Ostreids were the direct descendants of *Lima,* as Douvillé believes, they would probably reveal to a skilled embryologist such as Jackson some clue to the presence of a former attachment.

Two major groups of Ostreids have been established by Douvillé: in the one, he has assembled all the dominantly smooth forms, in the other, all the dominantly plicate. In both groups, he finds forms with straight umbones and those with gyrate beaks, and the outline of the species is, in his opinion, directly associated with the environment. Thus, the straight-beaked *Pycnodonta* is characteristic of deep and quiet waters, while forms with strongly twisted umbones, such as *Exogyra,* are developed in the more shallow waters, where there are strong currents to be resisted. If this theory be accepted, it is difficult to account for the frequent association of *Pycnodonta* and *Exogyra* in considerable numbers in the same marl bank. In his correlation also of the sculpture of the plicate group with their environment, his theories seem unwarranted by the facts. It is true, to be sure, that, as a rule, the right valve of the Ostreids is less vigorously sculptured than the left, but there is no evidence that the sculpture evanesces more rapidly in the littoral forms. On the contrary, a strong ribbing is most frequently developed where the need for resistance is greatest.

Douvillé as well as Jackson considers the *Gryphæas, Pycnodontas* and *Exogyras* as derivatives of the true oysters. Jaworski does not admit, however, that the Ostreids of the Triassic which have served as the theoretical ancestral types are true oysters. Steinmann traces the ancestors of the group even back of the Mesozoic and considers *Eurydesma* of the Permo-Carboniferous of Australia and India as the true ancestor of the Ostreid stock. This form is characterized by a heavy, lamellar shell, prosogyrate beaks, a marginal, posteriorly produced ligament, and possibly an incipient dentition. The most significant feature, namely, the character of the muscle impressions, is doubtful: the form has been commonly accepted until recently as monomyarian. Morris, however, observes "there is one large impression posteriorly and perhaps a small one anteriorly." If the presence of an anterior as well as a posterior scar can be established, *Eurydesma* would, in the opinion of Jaworski, fall in line behind *Heterostrea;* if its absence can be proved, *Eurydesma* should be considered as the ancestral form of the *Gryphæas* and *Exogyras.* It is *Heterostrea steinmanni* Jaworski which its describer considers the true ancestor of the true oyster.

The line of development between the two forms is, in his opinion, well defined, and easy to follow: the degree of coiling of the umbones is functional upon the ratio of the size of the left valve to the adhering surface; the larger the area of cementation, the stronger the tendency toward an elongate outline and straightened umbones; with the change in the direction of the beaks, there is a corresponding shift of the ligament from its original position along the posterior margin to a more effective point of attachment directly beneath the tips of the umbones. The obsolescence of the anterior adductor is doubtless the result of the shift of the antero-posterior axis consequent

upon the readjustment of the soft parts of the animal.

Jaworski evolves and develops another theory of phylogenetic relationship which seems so untenable that it may be disregarded —namely that the strongly plicated oysters such as the *Ostrea edulis* are the descendants of the strongly plicate *Gryphæas* of the Mesozoic. The surface sculpture is not a fundamental character among the oysters and there is no reason to search for its cause in distant ancestral relationships. Regarding the phylogenetic significance of *Heterostrea steinmanni* it would seem that it was an entirely too specialized form to have given rise to the subsequent *Ostrea* stock.

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SPECIAL ARTICLES

THE CHEMICAL DYNAMICS OF LIVING PROTOPLASM

Van't Hoff's formulation of the laws of chemical dynamics has proved so stimulating to various fields of chemistry that it may be expected to be similarly useful if it can be applied to the activities of living protoplasm.

The writer finds that by measuring the electrical resistance of living tissues it is possible to follow the progress of reactions in protoplasm in the same way that van't Hoff followed the progress of reactions *in vitro*. It therefore becomes possible to apply van't Hoff's methods and formulæ directly to protoplasm in its living and active condition. The following example will suffice to show how this may be accomplished.

The electrical resistance of living tissue of the marine alga *Laminaria* was measured by a method which has been previously described.[1] The tissue had in sea-water a resistance of 980 ohms.[2] On being placed in NaCl .52*M* (which had the same conductivity as sea-water) the resistance fell after 10 minutes to 855 ohms and after 20 minutes to 745 ohms: it continued to fall rapidly and finally became stationary at 320 ohms. This represents the death point. The total change produced by the NaCl was 980–320 = 660 ohms.[3] In order to find out whether this change had been produced in such a way as to correspond to a known type of chemical reaction the amount of change was measured at brief intervals. The results are given in Table I.

TABLE I

t=time in Minutes	Resistance	x=loss of Resistance	$a-x$	$\frac{a}{a-x}$	$\log_{10}\frac{a}{a-x}$	$k=\frac{1}{t}\times\log_{10}\frac{a}{a-x}$
0	980	0	660			
10	855	125	535	1.234	.0913	.00913
20	745	235	425	1.553	.1911	.00955
30	655	325	335	1.970	.2944	.00981
40	590	390	270	2.444	.3881	.00970
50	540	440	220	3.000	.4771	.00954
60	495	485	175	3.771	.5764	.00961
70	465	515	145	4.551	.6581	.00940
80	440	540	120	5.500	.7403	.00925
90	405	575	85	7.765	.8901	.00989
100	395	585	75	8.800	.9444	.00944
110	380	600	60	11.00	1.0414	.00947
120	366	614	46	14.35	1.1568	.00964
130	359	621	39	16.91	1.2281	.00 45
140	351	629	31	21.29	1.3282	.00949
150	345	635	25	26.40	1.4216	.00948
160	339	641	19	34.74	1.5408	.00963
200	320	660	0			.00953=
250	320	660	0	dead		Average
300	320	660	0			

a = total change = 980–320 = 660 ohms.
Temperature 18.5° C.

According to van't Hoff we can determine from such measurements whether one, two or more substances are taking part in the reaction. If only one substance takes part (or if two substances take part but only one of them changes its concentration noticeably) the reaction is said to be of the first order (monomolecular) and it proceeds according to the formula

$$k = \frac{1}{t}\log\frac{a}{a-x},$$

in which t is the time which has elapsed between the beginning of the reaction and the taking of the measurements, x is the loss in

[1] Science, N. S., 35: 112, 1912.

[2] If left in sea-water this resistance is maintained for a long time.

[3] The fact that this action of NaCl may be antagonized by $CaCl_2$ does not affect the subsequent discussion.